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The VLSI Reliability Research Group at the Faculty of Engineering, University of Malaya in Kuala Lumpur, Malaysia, is led by associate professor Ir. Dr. Norhayati Soin. The group is a well-established center for research in modeling and simulation analysis of reliability issues and performance of nanoscale semiconductor electronic devices and microelectromechanical systems (MEMS). The researchers also have ventured into very large scale integration (VLSI) emerging devices and architectures for cybersecurity. Long-standing collaborations with numerous international and national institutions include Liverpool John Moores University (U.K.), IMEC (Belgium), MIMOS Berhad and SilTerra (Malaysia), and the Malaysian offices of Intel and Infineon Technologies.

One of the main activities in recent years has been to expand the scope of the study in semiconductor defect-oriented aging and fabrication-induced randomness in field programmable gate array (FPGA)-based physical unclonable functions (PUFs) to strengthen Internet of Things (IoT) security, through collaboration with Liverpool John Moores University (LJMU). The proposed research embarks on a fundamental study to investigate the entropy variations of semiconductor materials as a foundation for development of security keys in the form of a PUF and integrate this physical entity into a commercial off-the-shelf (COTS) FPGA chip. The project aspires to develop sufficient study in the security of medical devices in order to influence the country’s policymakers and the mass public regarding the importance of containing hacks in insecure devices. Prior to this research, the group had collaborated with LJMU on developing an accurate circuit reliability simulator under the Newton Research Collaboration Program and was shortlisted for the Newton Prize in 2017. Through this project, a novel and fast wafer level characterization method and a compact transistor model, which embeds reliability and variability in the device, was developed.[1-3]

The group also has a significant record of research in the MEMS sector. The team developed systematic design and optimization flows for radio frequency (RF) MEMS devices such as switches, and integrated them into a MEMS application involving phase shifters. Specifically, the group developed a low-voltage RF-MEMS capacitive switch by using a novel combination of folded and spring beams, which are enhanced by a unique multi-response optimization method[4]. In addition, the group embarked on other novel MEMS research such as developing a unique flapping wing mechanism using MEMS technology to take advantage of unsteady aerodynamics.[5]

The researchers are also actively conducting a study on modeling and reliability characterization of sub-micron semiconductor devices such as high-k metal gate transistors and FinFETs[6-8]. In collaboration with RelMicroS (Turkey), the group conducts research on IC design for high
reliability solutions in critical applications including aerospace, avionics, and automotive. As a result, the group developed a comprehensive framework that eliminates the effect of aging degradation. The framework starts at the device level by modeling the effect of aging degradation for 16-nm FinFET technology, and concludes at the circuit level by proposing circuit level techniques that mitigate the effect of aging for 16-nm FinFET circuits. The group is currently conducting modeling and experimental characterization of graphene FETs, in collaboration with LJMU and MIMOS.

In addition, novel techniques for assessing the reliability mechanisms of devices were developed by looking at negative bias temperature instability (NBTI),[9-10] hot carrier injections (HCI), and probing of energy distribution of positive charges in gate dielectrics and its application to lifetime prediction.[11]

REFERENCES

IRPS WRAP-UP

INTERNATIONAL RELIABILITY PHYSICS SYMPOSIUM 2019

The 2019 International Reliability Physics Symposium (IRPS) was held at the Hyatt Regency in Monterey, Calif., March 31 to April 4. The conference was well attended by more than 400 participants from the U.S., Europe, Asia, and other regions of the world. IRPS was co-located with the International ESD Workshop (IEW). Participants from both events shared a Poster Reception including ESD research from IEW as well as 74 IRPS poster papers.

The symposium began with two days of tutorials covering introductory and advanced reliability physics topics. More than 100 platform presentations addressed failure mechanisms and testing considerations of semiconductor devices and microelectronic systems. At the same time, equipment and service exhibitors were located adjacent to presentation rooms. Exhibit representatives were kept busy meeting with attendees and answering equipment related questions. Despite the long days, the Tuesday evening workshops fueled by pizza and beer were productive and well attended.

The IRPS conference is sponsored by the IEEE Reliability Society and IEEE Electron Devices Society. The 2020 event will be held March 29 to April 2 in Dallas.